Vol. 111. Part 7. Pp. 157–174. 4 figs. 2 plates. 11th September, 1959

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ROYAL ENTOMOLOGICAL SOCIETY

OF

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World List abbreviation: *Trans. R. ent. Soc. Lond.*

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LONDON:
PUBLISHED BY THE SOCIETY AND
SOLD AT ITS ROOMS, 41, QUEEN'S GATE, S.W.7.

Price 8s. 6d.

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OBSERVATIONS ON THE TIPULIDAE (DIPTERA) OF THE MOOR HOUSE NATURE RESERVE, WESTMORLAND

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[Communicated by Dr. E. T. Burtt]

Manuscript received 17th April, 1958

(Read 5th November, 1958)

With 2 Plates and 4 Text-figures

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I. Introduction

The systematic collecting of Tipulidae (Diptera) in Great Britain has been almost completely restricted to altitudes below 1,000 feet. This is surprising since both Barnes (1925) in this country and Rogers (1933, 1942) in U.S.A. showed that species of this family were most abundant in wet habitats. Barnes (1925) carried out systematic collecting from a number of habitats in Caernarvonshire, while Brown and Duncan (1949) have studied the crane-flies of south-west Scotland and Crisp and Lloyd (1954) described the Tipulidae and other insects found in woodland mud. The late C. A. Cheetham collected extensively in Yorkshire and his collections are at present in the possession of Dr. H. Henson, of Leeds University, and the Leeds Museum, while a few specimens are in the British Museum.

The present investigation was carried out at Moor House, a Nature Conservancy Reserve in Westmorland, to provide biological information on the

Tipulidae occurring on a typical Pennine moorland. The study was made between 1954 and 1956 inclusive, with less extensive observations during 1952, and 1953 and 1958. During this period, 67 species or varieties of Tipulidae were recorded from the Reserve.

II. THE STUDY AREA

The Moor House Nature Reserve (N.R. 80), Westmorland, comprises some 10,000 acres (4,000 hectacres), covering part of the scarp and dip slope of the Pennines, immediately south of Cross Fell (*see* Conway, 1955). The Reserve is bordered on the north and east by the source of the River Tees and reaches an altitude of 2,780 feet (the summit of Great Dun Fell). The majority of collections were made between 1,750 and 2,050 feet.

According to Dunham (1948) the area consists of stratified beds of sandstone, shale and limestone, with occasional mineral veins and pockets.

Most of the surface is covered by blanket bog and the Reserve can be divided into four arbitrary topographical or vegetational types which tend to merge into one another. These are :—

(1) The high slopes of the fells where the peat deposits have been almost completely eroded. These areas are usually covered by an arctic or sub-arctic vegetation (Lewis, 1904).

(2) The bulk of the Reserve, covered by a blanket of peat, which, in places, may exceed 3 metres in depth. This blanket bog area can be divided into

(*a*) areas where peat erosion is taking place, now characterised by extensive peat-hags with a complex association of *Calluna*, *Cladonia* and *Eriophorum*, and

(*b*) areas of actively growing bog, characterised by *Sphagnum* and *Eriophorum* and a reduction in the amount of *Calluna* (Plate I, fig. 1).

(3) Areas of shallow peat, usually situated on the edge of the peat blanket and dominated by *Juncus squarrosus* (Plate I, fig. 2).

(4) Areas devoid of peat, with a mineral soil and dominated by grasses. These areas consist of rock outcrops and alluvial terraces along the sides of streams. The infrequent limestone outcrops carry a typical calcicole flora but most of the grassland lies on the top of drift and supports a less luxuriant flora.

Manley (1936, 1943) has described the climate at Moor House as sub-arctic, being similar to that at sea level in southern Iceland. He estimated that the average annual rainfall was 70 inches.

III. METHODS

Two methods of collecting were employed. In the first place, suitable parts of the study area were visited weekly and collections made by using a sweep net. Secondly, adhesive traps covered with "Stik-tite" (Broadbent, 1948) were placed in suitable localities and examined weekly. Tipulidae captured on these traps were removed by dissolving the adhesive in ethyl acetate and they were then preserved in alcohol.

In addition, larvae were collected and bred in order to confirm the larval habitat.

IV. LIST OF AND NOTES ON THE SPECIES

The nomenclature and identifications follow Coe (1950). Species marked with an asterisk are apparently restricted to upland areas.

(1) *Dolichopeza albipes* Ströem. Adults were taken from only one locality but pupae were found in a second. The tarsus of the adult is elongated and hairy, apparently being adapted to support it on the surface of water. When the weak flying adults are disturbed, they escape by moving across the surface of the stream, using the wings for propulsion and the legs as floats.

Larvae were found among mosses and liverworts on the banks of Moss Burn. Audcent (1932) described the larval habitat as "moss on tree trunks" but Cuthbertson (1926) described the habitat as the banks of streams.

(2) *Nephrotoma submaculosa* Edwards. Adults were taken commonly on mineral soils in 1952 and 1953 but were not taken in 1954. In 1955 ten adults were taken on grass-covered shingle beside the River Tees. The marked reduction in numbers in 1954 cannot be explained.

(3) *Tipula paludosa* Meigen. This species, like *N. submaculosa*, was also very abundant in 1952 and 1953, but the adult population was noticeably reduced in 1954 and 1955. Adults have been taken up to an altitude of 2,300 feet on the Reserve. Barnes (1925) recorded this species at an altitude of 1,500 feet in north Wales. The larvae occur on alluvial soils.

(4) *Tipula oleracea* Meigen. This species was taken for the first time in 1955 when five adults were collected. It seems possible that, as it is large and strong flying, this species may be one of the few which, under suitable wind conditions, may fly from the lowlands of the Eden Valley.

(5) *Tipula czizeki* de Jong. Mannheims (1946–51) gives evidence that this species should be called *T. fusca* Staeger. Only one specimen was taken and that an adult collected at an altitude of 1,800 feet. It has been recorded at over 1,000 feet on the Pentland Hills, near Edinburgh, and at 2,100 metres in the Alps (Brown, 1947 ; Mannheims, 1946–51).

(6) *Tipula cheethami* Edwards. Only seven adult specimens were taken on the Reserve. Bryce (1956) has stated that this species is associated with basic conditions, which occur only in close proximity to the infrequent limestone outcrops at Moor House. This may account for its rarity.

(7) *Tipula rufina* Meigen. This species was restricted, adults being recorded only from three localities. Both Mannheims (1946–51) and Brown and Duncan (1949) indicate that, unlike most other members of the genus, this species has two generations per year. However it seemed doubtful that this was so at the higher altitude at Moor House, since all but one of 41 adults captured were taken during May. Data from Iceland, which has a similar climate, suggest that there is only one generation a year (Nielsen, Ringdahl and Tuxen, 1954).

(8) *Tipula alpium* Bergroth.* This was a common species over the moor, being closely associated with vertical surfaces such as peat hags and the rocky banks of streams. The adults were frequently found in close association with such sites and they probably find shelter on these surfaces during cold and rainy weather. Plate II, figure 1 shows a typical sheltering site on a peat hag.

This species, like *T. rufina* which has a similar association with vertical surfaces, emerges with unripe eggs and it seems possible that this increases the chance of females surviving until the eggs are ripened and laid. Larvae of *T. alpium* have been collected from moss growing on the vertical bank of a stream and a single larva was taken from moss growing on the edge of a peat hag.

(9) *Tipula staegeri* Nielsen. The distribution of this species was local, and adults and larvae were taken only in the vicinity of limestone outcrops.

(10) *Tipula marmorata* Meigen. Adults were local and uncommon at Moor House.

The larvae were found in the same cushion of moss on the bank of a stream as larvae of *T. alpium*.

(11) *Tipula subnodicornis* Zetterstedt.* In 1954 and 1955 this was certainly the most abundant tipulid on the Reserve, occurring over most of the areas that were covered by peat. Audcent (1932) states that it is " plentiful only on bogs where cotton-grass (*Eriophorum vaginatum* Linn.) grows ". At Moor House large larval populations existed on cotton-grass areas but the largest populations were recorded from areas dominated by *Juncus squarrosus* (Plate I, fig. 2). In 1956, adults were uncommon, and the species had disappeared from many areas where in the previous years it had been abundant.

(12) *Tipula melanoceros* Schummel.* Adults occurred in a very local habitat, namely areas of flat boggy ground on which water tended to stand, and characterised by *Polytrichum commune* and *Juncus effusus*.

(13) *Tipula pagana* Meigen var. *pagana*. This was a common species, emerging in late autumn, but restricted to alluvial areas. In October, 1955, adults were noted to occur along the alluvial sides of streams almost to their source and as far as the alluvial stream edges penetrated.

(14) *Tipula montium* Egger.* Adults were recorded from three small streams on the Reserve, all of which drained off peat. Audcent (1932) stated that the adults occur in the late summer, but it was almost entirely an early spring species at Moor House. The larvae are aquatic.

(15) *Tipula coerulescens* Lackschewitz.* This species is related to *T. montium*, both belonging to the *lateralis* group. The larvae live in small streams, apparently similar to those used by *T. montium* but these two species have never been taken in the same stream. The record from Moor House is the second locality record from England and the third from Great Britain. The other records are from Austwick (Ingleborough, Yorkshire) and Aviemore (Scotland) (Coe, 1950).

(16) *Tipula variipennis* Meigen. Larvae were confined to alluvial areas, although the species seemed to penetrate into areas where the soil contained a noticeable proportion of peat.

(17) *Tipula gimmerthali* Lackschewitz.* In the field, the adult males resembled *T. pagana* (which was on the wing at the same time), but were very locally distributed. They were never found far away from flushes which were the larval habitat. This is the first record of *T. gimmerthali* from England, the only other record from Great Britain being that of Brown (1947), who recorded it from about 1,000 feet in the Pentland Hills, Scotland.

(18) *Tipula macrocera* Zetterstedt.* Adults appeared to be restricted to *Sphagnum* flushes on peat bogs and were taken on six different flushes.

(19) *Tipula vafra* Riedel.* Adults were common in restricted localities but

the larval habitat was not discovered. These records are the second locality record from England, the only other localities being Morayshire, Scotland, and Austwick, Yorkshire (Coe, 1950).

(20) *Tipula excisa* Schummel.* This species was also common in restricted areas, the larval habitat being amongst shingle and rock debris (Plate II, fig. 2). Adults were collected as low as 1,700 feet.

(21) *Phalacrocera replicata* L. Adults and larvae were recorded from three ponds on the Reserve, all of which had an extensive growth of *Sphagnum*. Many similar ponds, however, contained no larvae. The closely related *Triogma trisulcata* Schummel has not been recorded, although Coe (1950) states that it is " uncommon on bogs ".

(22) *Limonia nubeculosa* Meigen.
(23) *Limonia flavipes* Fabricius.
(24) *Limonia dilutior* Edwards.
(25) *Limonia maculata* Meigen.
(26) *Limonia chorea* Meigen.
(27) *Limonia mitis* Meigen.
(28) *Limonia modesta* Meigen.
(29) *Limonia autumnalis* Staeger.

Species 22 to 29 were all rare and less than ten individuals of each were recorded.

(30) *Limonia didyma* Meigen. Larvae were associated with mosses splashed or temporarily covered by stream water. Oviposition has been observed on moss on the edge of a small waterfall.

(31) *Limonia morio* Fabricius.* Adults were uncommon and most of the material was taken from alluvial terraces with occasional clumps of *Juncus effusus*.

(32) *Limonia stylifera* Lackschewitz.* This species had a similar distribution to *Limonia morio*. This is the first record from England.

(33) *Pedicia rivosa* Linnaeus. Adults of this large tipulid were taken in July and August, 1953, but none were recorded in 1954 or 1955. The larvae were taken from Sphagnum flushes and also from the mud and peat at the bottom of sink holes in the peat.

(34) *Trichyphona schummeli* Edwards.* In 1953 and 1954 only two specimens were taken but in 1955 the species was more numerous and many adults were taken over the moor. Its habitat does not appear to differ from that of *T. immaculata*, adults of both species being found in the same areas, but emerging at different times of year.

(35) *Trichyphona immaculata* Meigen. This was a common peat-inhabiting species. It appeared to have only one generation a year at Moor House, although a small number of adults were taken in late September each year. General observations at low altitudes suggested that there were at least two well marked emergences during the year.

(36) *Dicranota robusta* Lundstroem.* Adults were taken on the rocky edge of a stream (Trout Beck) in 1955. The wings are markedly reduced in both sexes and they are incapable of flight. This, with their small size and restricted habitat, makes the adults extremely easy to overlook. This is the second locality record from Great Britain, the species having been recorded previously from Derbyshire. (Edwards, 1939.)

The larvae, like those of all other members of the genus, are probably aquatic.

(37) *Dicranota subtilis* Loew.* Two adult male specimens were taken, both from the bank of a stream (Moss Burn).

(38) *Dicranota brevitarsis* Bergroth.* Only three adult specimens were obtained, all from the edge of streams. The rarity of *D. subtilis* and *D. brevitarsis* may be due to the limited collecting carried out on stream-side shingle; further collecting in such areas may show that these species are not uncommon.

(39) *Dicranota bimaculata* Schummel. The larval habitats of this species and of *D. guerini* appear to be similar to those of *Tipula montium* and *T. coerulescens*, namely small streams with much vegetation.

(40) *Dicranota guerini* Zetterstedt.* Adults were commonly taken in 1955. This is the second locality record from England, the first being from Austwick, Yorkshire (C. A. Cheetham's collection in B.M.). Coe (1950) gives three localities from Scotland.

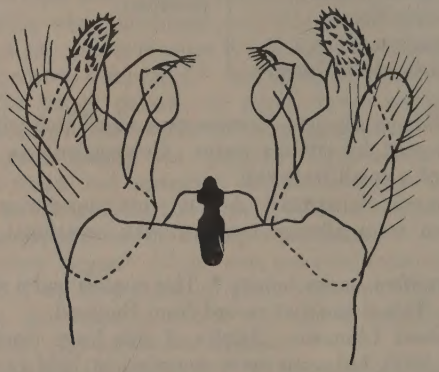


Fig. 1.—Male hypopygium of *Dicranota gracilipes*. (*Cf.* drawings of hypopygium of other British species in Coe (1950).)

(41) *Dicranota exclusa* Walker.* This species was locally common by the edge of streams. Females were observed ovipositing in the clay bank of a stream, about 1 cm. above the water level. This is the first record of this species for England, although it has been recorded from Scotland and Wales (Coe, 1950).

(42) *Dicranota* (*Paradicranota*) *gracilipes* Wahlgren.* A series of adults were taken in September, 1958, on the banks of a small rocky moorland stream ($\frac{1}{2}$ to $1\frac{1}{2}$ metres wide). These specimens constitute the first record of this species from Great Britain and agree with material of this species from Latvia in the British Museum (determined by Dr. P. Lackschewitz).

This species differs from the other four British species of the sub-genus *Paradicranota* (*see* Coe, 1950) in having wing-cell M_1 present (in all 14 specimens examined), and the ground colour of the thorax and coxae brownish, while the wings are long and distinctly narrower than in any other British species (wing about four times as long as broad). The male hypopygium (fig. 1) is distinctive;

the lateral processes of the tergite are short and blunt and the parameres have conspicuously swollen tips, which are twice the diameter of the stem.

(43) *Hexatoma bicolor* Meigen.* One specimen was taken in 1953. None were taken in 1954, but, in 1955, adults were taken commonly by the River Tees.

(44) *Dactylolabis sexmaculata* Macquart. One specimen taken.

(45) *Limnophila meigeni* Verrall.* A peat inhabiting species which was common in 1953 and 1954 but scarce in 1955. The larvae, which are found in peat soils, are figured by Nielsen, Ringdahl and Tuxen (1954).

(46) *Limnophila fulvonervosa* Schummel. This species was closely associated with *Juncus effusus* growing in surface flush conditions and was never taken away from this plant.

(47) *Limnophila squalens* Zetterstedt.* Although Edwards (1938) recorded this species as common on peat bogs, only a few specimens were taken at Moor House, and these were confined to the vicinity of water trickling over re-deposited peat.

(48) *Limnophila pulchella* Meigen.* An uncommon species, the adults being usually taken on the edge of *Sphagnum* bogs and areas with exposed peat. This species is recorded in the Cheetham collection as being common on the bog moors near Austwick, Yorkshire.

(49) *Limnophila trimaculata* Meigen.* Only six adults collected.

(50) *Limnophila mundata* Loew. This species was not recorded in 1953, and in 1954 only one adult specimen was obtained. In 1955, adults were taken abundantly, especially along the sides of streams. At sunset, swarming males were encountered over the banks of the streams.

(51) *Limnophila punctata* Schrank. Larvae were associated with small streams containing a thick growth of vegetation, a habitat in which *Tipula coerulescens* also occurred. Larvae were taken from the mud on the edges of these streams.

(52a) *Limnophila nemoralis* var. *nemoralis* Meigen. Adults of this variety were confined to areas of *Juncus effusus* growing on alluvial soils.

(52b) *Limnophila nemoralis* var. *separata* Walker.* According to Coe (1950), this species occurs in hilly districts of Britain. It was common on the peat moor at Moor House and was one of only three species noted to swarm in the area. The swarming usually took place over a peat hag.

These two varieties differed in the following characteristics in addition to those given by Coe (1950).

	var. *nemoralis*	var. *separata*
Size :	Larger, wing 7–10 mm.	Smaller, wing 5–7 mm.
Colour :	Body greyish	Body light yellow-brown.
Antenna :	All segments dark	Base yellowish.
Wing :	Broad, distinct angle on hind margin near 2A	Tending to be narrow, and lacking an angle on hind margin near 2A.
Legs :	Femur dark tipped	Femur light brown, without a dark tip.
Male genitalia :	Identical	Identical.

Table III shows that the flying periods of these two varieties were different, although there was a slight overlap. Further, adults of the two varieties were taken within 50m. of each other on the same day, although each

was taken in its own particular habitat. These differences support Edwards (1938), who considered that the variety *separata* may possibly be regarded as specifically distinct from *nemoralis*.

(53) *Gonomyia dentata* de Meijere. This species was common on the peat moor in 1953 but was not collected in 1954 and was rare in 1955.

(54) *Gonomyia conoviensis* Barnes. A single male specimen was taken in 1955.

(55) *Rhabdomastix hilaris* Edwards.* Three specimens were taken on river side shingle beds (River Tees). This is the first record of this species from England.

(56) *Platytoma cinerascens* Meigen. Six adult specimens were taken, all during 1955.

(57) *Erioptera lutea* Meigen. Adults were taken from the stream in which *Limnophila maculata* and *Tipula coerulescens* were found.

(58) *Erioptera fuscipennis* Meigen. Adults were taken in 1955 on the silt edge of small streams and ponds.

(59) *Erioptera trivialis* Meigen. This was a common species, particularly during 1955. The larvae occurred in silt and mud on the edges of small pools.

(60) *Erioptera diuturna* Walker.* This was a late autumn emerging species, very similar to *E. trivialis* and occurring in similar habitats.

(61) *Erioptera stictica* Meigen. A single female specimen was taken in 1954.

(62) *Ormosia lineata* Macquart. Adults were taken occasionally during the spring.

(63) *Ormosia hederae* Curtis. Adults were taken commonly in 1955, mainly because the larval habitat was discovered. This was a moss, grass and liverwort community found at the base of limestone outcrops. Adult males were noted swarming at sunset.

(64) *Ormosia pseudosimilis* Lundstroem.* A common species inhabiting *Calluna* and *Juncus squarrosus* moor. Although fully winged, the adults rarely flew and were usually observed crawling over the vegetation.

(65) *Molophilus ater* Meigen.* A common spring species in which both sexes are subapterous. The habitat is similar to that of *Ormosia pseudosimilis*.

(66) *Molophilus griseus ?* Meigen. A single adult winged female belonging to the genus *Molophilus* was obtained in October, 1954. A comparison with material in the British Museum suggested that it probably belonged to this species.

V. THE AFFINITIES OF THE MOOR HOUSE TIPULID FAUNA

Sixty-six of about 300 species of the family Tipulidae known from Britain have been recorded on the Moor House Nature Reserve. These species may be divided into three major groups according to the larval requirements: those with completely aquatic larval stages (16 species), those apparently confined to moorland (16 species) and those which are more widely distributed and occur in terrestrial habitats at low altitudes (17 species). Too little information is available on the remaining 17 species to classify them with certainty.

(1) *Species with aquatic larvae.*

The distribution of these species, e.g. *Tipula montium*, *T. cheethami*, *T. coerulescens*, *Limonia punctata* and members of the genus *Dicranota*, depends upon the distribution of suitable streams. Species which appear to require a fast flowing stream with a rocky stream bed (e.g. *Dicranota gracilipes*, *D. robusta*) tend to be restricted to high altitudes but not necessarily to moorlands.

(2) *Species confined to moorland.*

Only 16 species which occur at Moor House fall into this group. These are :— *Tipula alpium*, *T. subnodicornis*, *T. melanoceros*, *T. macrocera*, *T. gimmerthali*, *T. vafra*, *T. excisa*, *Limonia stylifera*, *Limnophila meigeni*, *L. squalens*, *L. pulchella*, *L. trimaculata*, *Trichyphona schummeli*, *Erioptera diuturna*, *Ormosia pseudosimilis* amd *Molophilus ater*.

(3) *Species with terrestrial larvae and which are not restricted to moorland.*

Species falling into this group either have larval habitats which are found both at low altitudes and on moorland, or occupy a different habitat at low altitudes from that utilised on moorland. Thus the larvae of *T. marmorata* and *T. staegeri* live in mosses of many species and are also found in woodland. *Erioptera trivialis*, *Pedicia rivosa* and *Trichyphona immaculata* spend their larval stages in peat or wet mud, and larvae of *T. paludosa*, *T. pagana* and *T. variipennis* occur in agricultural grassland as well as in the alluvial grassland along the edges of moorland streams.

Of the 66 species of Tipulidae recorded at Moor House, 50 occur in Denmark, 59 in Sweden or Norway and 50 are known to occur north of latitude 60° N. in Norway, Sweden or Finland, but only 38 have been recorded in France (Pierre, 1924 ; Lackschewitz, 1935 ; Tjeder, 1955). All 16 of the strictly moorland species found at Moor House have also been recorded from northern Norway or Sweden, but only 11 from Denmark and 5 from France. Only 13 species are known from Iceland (Nielsen, Ringdahl and Tuxen, 1954) and 9 of these also occur at Moor House but only one, *Limnophila meigeni*, is a strictly moorland species.

These data suggest that the species composition of the Tipulidae of upland moorland in Britain has a close affinity with the upland fauna of northern Scandinavia.

VI LARVAL HABITATS ON THE MOOR HOUSE RESERVE

It was uncommon to find an adult tipulid far away from its larval habitat and if numbers were taken in a particular habitat, it was fairly certain that this was the larval habitat. This was often confirmed by rearing larvae or, alternatively, by finding adults in the process of emergence or egg laying.

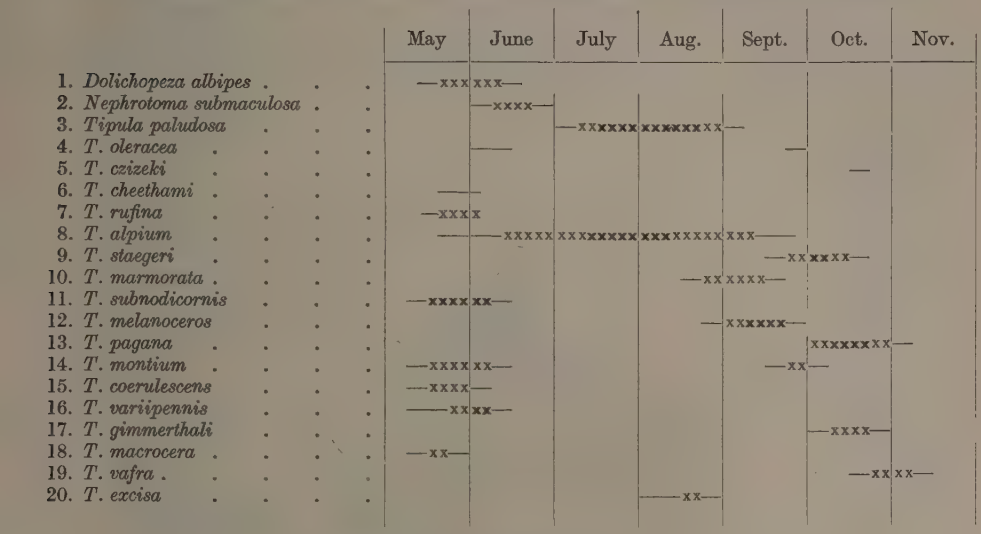
Table I shows the larval habitats on the Moor House Reserve divided into 17 arbitrary sections. These become progressively drier towards the right hand side of the table, and it is evident that Tipulidae were most abundant in wet habitats and few species were found on the better drained areas.

Species not recorded in Table I were too rare for their larval habitats to be determined.

TABLE I.—*The distribution of larval habitats at Moor House.* (× *indicates that larvae were recorded from the habitat, and C that larvae were found frequently.*)

	Swift, rocky streams	Small streams with vegetation	Temporary peat pools	Pools on alluvial soils	*Sphagnum* bog	*Sphagnum* flush	Alluvial flush	*Calluna*—*Sphagnum* moor	*Eriophorum* moor	*Juncus squarrosus* moor	*Calluna*—Cladonia moor	Vegetation below rock outcrops	Alluvial grassland	Limestone grassland	Mosses on stream banks	Mosses on rocks	Raised shingle beds
1. *Dolichopeza albipes*															×		
2. *Nephrotoma submaculosa*													×				
3. *Tipula paludosa*													C	C			
6. *T. cheethami*																×	
7. *T. rufina*																×	
8. *T. alpium*															×	×	
9. *T. staegeri*															×	×	
10. *T. marmorata*															×	×	
11. *T. subnodicornis*					×			C	C	C	×						
12. *T. melanoceros*			×														
13. *T. pagana*													C	×			
14. *T. montium*		C															
15. *T. coerulescens*		C															
16. *T. variipennis*													C	×			
17. *T. gimmerthali*							C										
18. *T. macrocera*						C											
20. *T. excisa*																	C
21. *Phalacrocera replicata*				×													
30. *Limonia didyma*															×		
31. *L. morio*													×	×			
33. *Pedicia rivosa*					×	×											
34. *Trichyphona schummeli*								×		×							
35. *T. immaculata*					×			C	C	C	×						
36. *Dicranota robusta*	×																
37. *D. subtilis*	×																
38. *D. brevitarsis*	×																
39. *D. bimaculata*	×	C															
40. *D. guerini*	×	C															
41. *D. exclusa*	×																
43. *Hexatoma bicolor*	×																
45. *Limnophila meigeni*								×		C							
48. *L. pulchella*								×	×								
50. *L. mundata*	×																
52*b*. *L. nemoralis* var. *separata*													×				
57. *Erioptera lutea*		×															
58. *E. fuscipennis*		×		×													
59. *E. trivialis*		C					×	×		C							
60. *E. diuturna*							×	×		×							
62. *Ormosia lineata*												×					
63. *O. hederae*												C					
64. *O. pseudosimilis*								×		C							
65. *Molophilus ater*								×		C							

TABLE II.—*The seasonal distribution of adult, long-palped crane-flies at Moor House.* (—, *at least one adult;* xx, 4 *to* 10 *adults,* **xx**, *more than* 10 *adults taken per week.*)



VII. THE SEASONAL DISTRIBUTION OF ADULTS

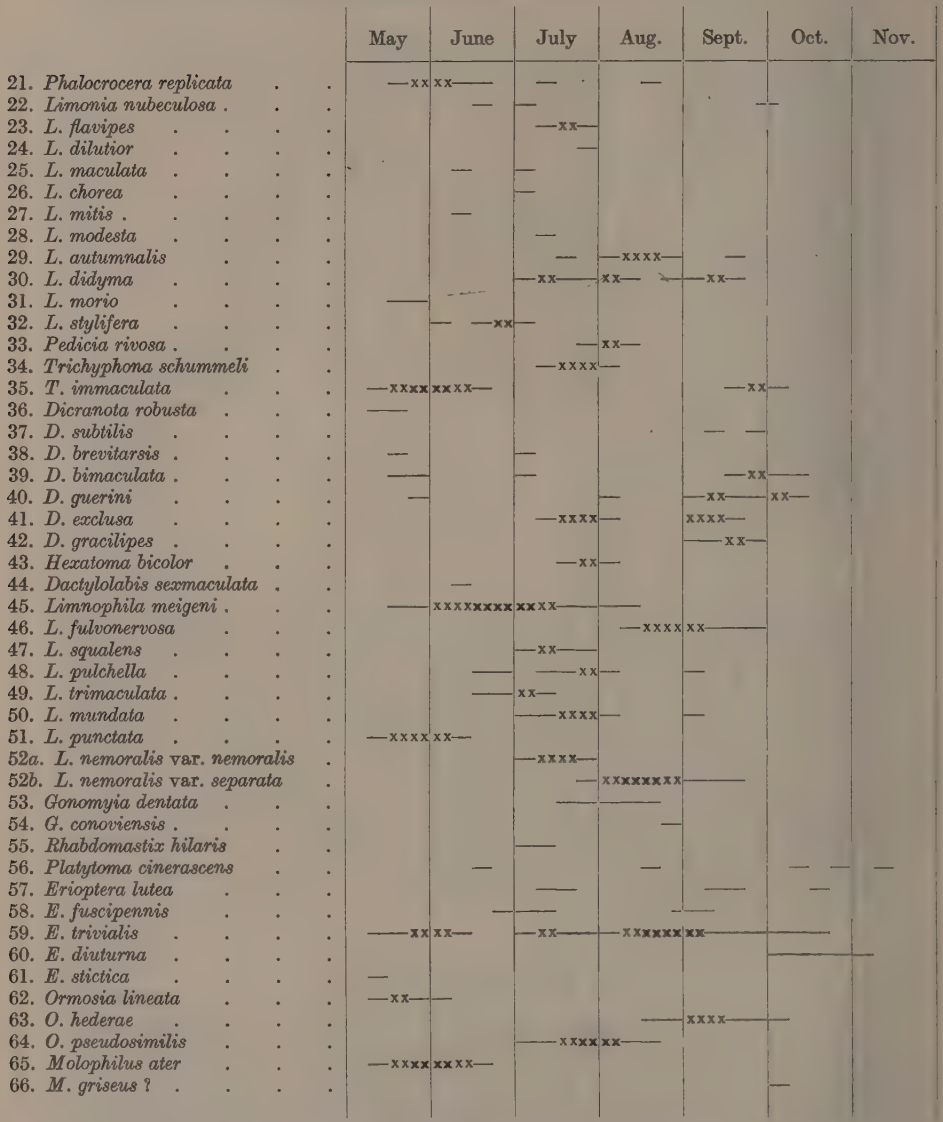
The monthly occurrence of adults of different species throughout the year is shown in Tables II and III. The time of appearance of adults of most species was similar in each of the three years of study and observations for all three years have been grouped together. It is interesting to note that the adults of most species were recorded over a period of less than eight weeks and that the period of abundance was much shorter. It should also be noted that adults with a peak of emergence in July or August were present for longer periods than spring or late autumn emerging species. Since adult tipulids rarely live more than a few days, it is suggested that the pupation of the summer emerging species was spread over a longer period than that of the spring or autumn species, but further observations are required.

VIII. A COMPARISON OF ABUNDANCE OF TIPULIDAE IN DIFFERENT VEGETATIONAL TYPES

A study of the comparative numbers of Tipulidae on different vegetational types was carried out in 1954 and 1955. In 1954, sticky traps were erected in three areas: (1) a deep peat moor dominated by *Calluna* and *Sphagnum*, (2) a shallow peat area (less than 1 m. of peat) dominated by *Juncus squarrosus*, and (3) an alluvial grassland area, containing a certain amount of limestone drift. In 1955 the observations on the deep peat moor were discontinued.

The suitability and effectiveness of sticky traps, suction traps and tow nets in capturing airborne insects has been studied by Johnson (1950), who came to the conclusion that, while the suction trap was the most efficient means of

TABLE III.—*The seasonal distribution of adult, short-palped crane-flies.*
(Symbols as in Table II.)



sampling aphid populations, sticky traps were most successful in capturing insects over $\frac{1}{4}$ inch long.

Sticky traps measure activity, but if the insects captured are grouped over long enough periods, then they also give a comparative measure of abundance.

Figure 2 shows the captures of *Tipula subnodicornis* adults in 1954 grouped into three-day periods. The smooth distribution suggests that the captures, grouped into as short a period as three days, gave a good representation of abundance. In figures 3 and 4 the captures are grouped into 14 day periods.

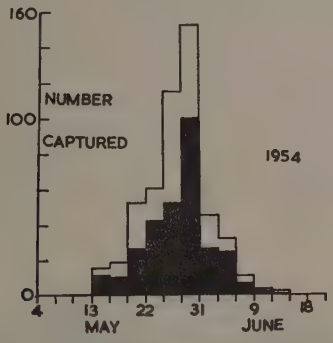


FIG. 2.—Total captures of *Tipula subnodicornis* on sticky traps, 1954. (Dark area indicates proportion of males.)

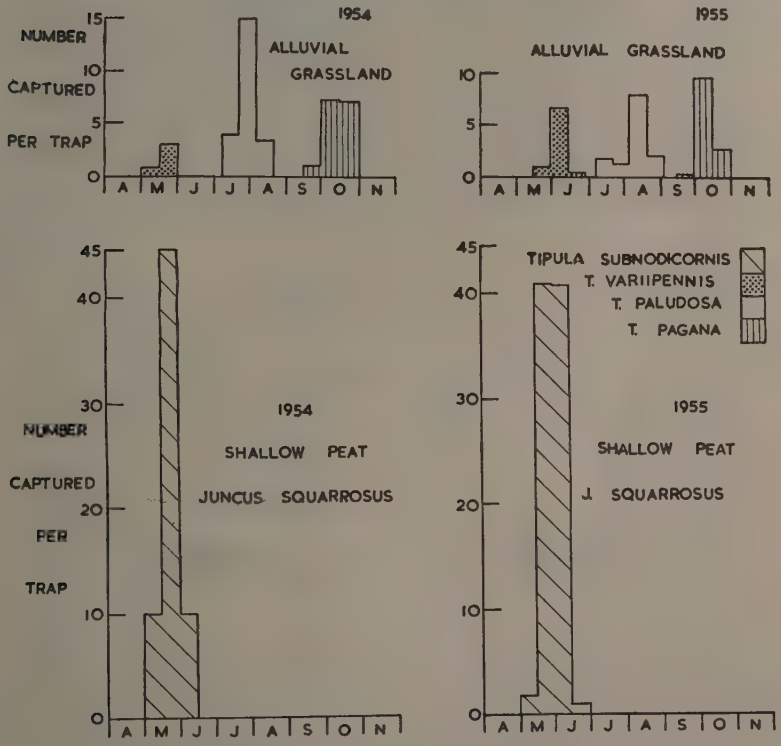


FIG. 3.—Captures of long-palped crane-flies on 12 sticky traps, 1954 and 1955.

The long-palped crane-flies (Tipulinae) were larger and apparently more active than the short-palped crane-flies (remaining sub-families), and these two groups have been considered separately.

The seasonal distribution of numbers captured on sticky traps is shown in figures 3 and 4. On the peat moor, the Tipulinae represented only one peak, caused by the emergence of *Tipula subnodicornis* in late May and early June. However, on the alluvial area, three smaller peaks were observed, one in late May and early June, one in July and August and one during October, produced by the emergence of *T. variipennis*, *T. paludosa* and *T. pagana* respectively.

The short-palped crane-flies also showed a distinct peak in numbers on the peat moor in late May and early June. This was almost entirely caused by the emergence of *Trichyphona immaculata*. *Molophilus ater* appeared to be at least

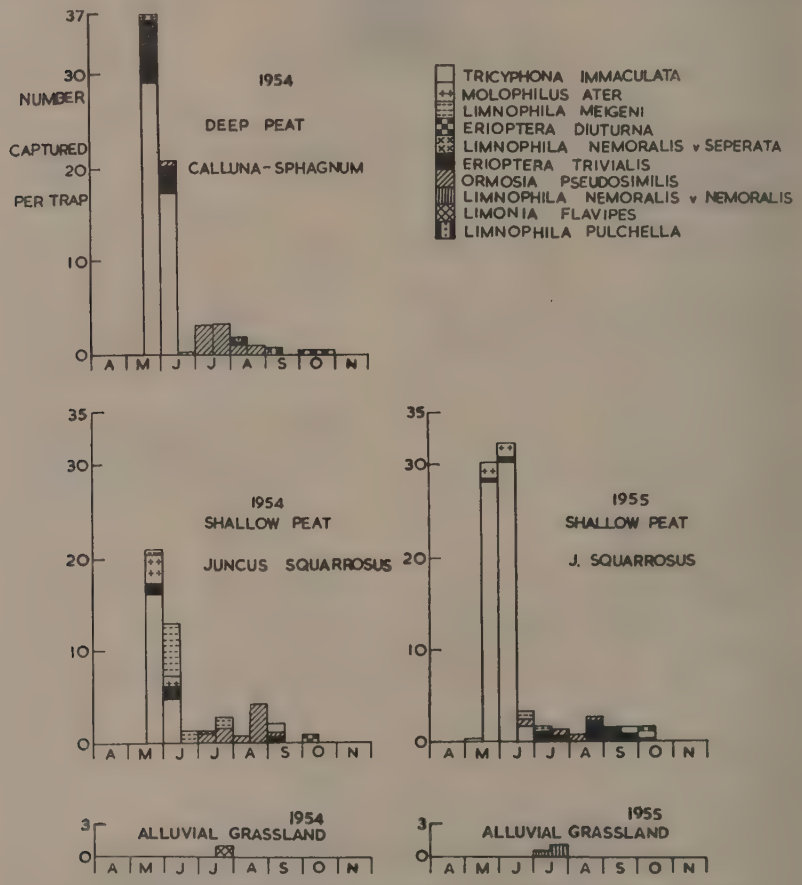


FIG. 4.—Captures of short-palped crane-flies on 12 sticky traps, 1954 and 1955.

as common as *T. immaculata* during this period, but captures were fewer because this species is unable to fly, both sexes being subapterous.

The alluvial grassland was virtually devoid of short-palped crane-flies and only four specimens belonging to two species were taken.

A comparison of the captures of small-palped crane-flies in 1954 on the *Juncus squarrosus* moor and the deep peat moor dominated by *Calluna* and *Sphagnum* shows that the form of emergence and numbers of each species were similar, except that *Erioptera trivialis* was commoner on the deep peat moor.

There were marked differences between the species, and seasonal distribution of numbers of tipulids on peat and alluvial areas at Moor House. There was one major peak of emergence on the peat moor, caused by the emergence of *Tipula subnodicornis*, *Trichyphona immaculata* and *Molophilus ater*, while in the alluvial areas there were three peaks, distributed through the season and produced by *Tipula variipennis*, *T. paludosa* and *T. pagana* in turn.

IX. THE EGG FILAMENT

Hemmingsen (1952) postulated that the egg filament, which is found in many Tipulinae, was a means of anchoring the egg in the substratum and was found only in species whose eggs were laid in a wet environment. He showed that these filaments were widespread throughout the Tipulinae, and that apparently closely related species could differ in that one possessed the filament while the other lacked it. Table IV lists the species which were examined for the presence of an egg filament and shows that 13 species occurring at Moor House were found to possess it, while 4 did not. This is a larger proportion of species with an egg filament than that given by Hemmingsen (1952) for Danish species (13 with and 11 without). Moor House has a very high rainfall and this difference may support Hemmingsen's belief that the filament is related to a wet environment.

TABLE IV.—*Species of Tipulinae recorded from Moor House and examined for the presence of an egg filament*

A. Filament present—

Dolichopeza albipes	*T. pagana*
Tipula oleracea	*T. coerulescens*
T. montium	*T. alpium*
T. marmorata	*T. rufina*
T. macrocera	*T. staegeri*
T. vafra	*T. melanoceros*
T. gimmerthali	

B. Filament absent—

T. paludosa	*T. subnodicornis*
T. variipennis	*T. excisa*

Tipula subnodicornis is a marked exception to this hypothesis as it has no egg filament and lays in much wetter habitats than *T. pagana*, a species which does have an egg filament. Furthermore, species whose larvae inhabit mosses may live in relatively dry conditions. This would appear to be the case with the larval habitats of *Tipula marmorata*, *T. alpium* and *T. staegeri*, and all

these species have eggs which possess a filament. In these cases, the filament may help to anchor the egg within the relatively restricted larval habitat of a moss cushion preventing it from falling or being washed away by rain which would not remove the eggs from an extensive habitat such as alluvial grassland.

X. THE STATE OF EGGS IN NEWLY EMERGED FEMALES

The dissection of newly emerged females has shown that the majority of species of Tipulinae emerge with the eggs fully developed within the abdomen, while few species emerge with immature eggs (Table V). It is interesting to note that *Tipula alpium* and *T. rufina*, the only species found to emerge with partially developed eggs at Moor House, frequently rested on vertical surfaces, which presumably afforded the females some protection until the eggs matured.

TABLE V.—*The state of eggs at emergence of species of Tipulinae recorded from Moor House*

A. Species with fully developed eggs.	Chorion black.	
	Tipula paludosa	*T. oleracea*
	T. subnodicornis	*T. montium*
	T. coerulescens	*T. pagana*
	T. variipennis	*T. marmorata*
	T. gimmerthali	*T. excisa*
	T. melanoceros	*T. macrocera*
B. Species with unripe eggs.	Chorion absent or transparent.	
	T. alpium	*T. rufina*

XI. SUMMARY

Sixty-six species of Tipulidae were recorded from the Moor House Nature Conservancy Reserve. Of these, two species were recorded for the second time from Great Britain, while four others were recorded for the first time in England.

The Tipulid fauna at Moor House appears to have strong affinities with that of Scandinavia.

The larval habitats of some of the species and the seasonal distribution of the adults are recorded. There were marked differences in the numbers, time of abundance and species composition of Tipulidae found on the peat moors and neighbouring alluvial grassland.

All but two species (*Tipula alpium* and *T. rufina*) of the 20 recorded at Moor House were found to emerge with fully developed eggs in the abdomen.

Hemmingsen's hypothesis that the occurrence of an egg filament in the Tipulinae is related to a wet larval habitat is supported by the Moor House data, where 13 species possessed such a filament and only four were without it—a higher proportion of species having filaments than that given by Hemmingsen's data for Danish species.

XII. ACKNOWLEDGMENTS

The author wishes to express his thanks to Professor J. B. Cragg for guidance and encouragement throughout the investigation and to Mr. D. V. Kelly for

taking the photographs reproduced in Plates I and II. The study was carried out while the author held Research Studentships from the Durham Colleges and the Nature Conservancy and he is grateful to the latter body for permission to work on their Moor House Reserve.

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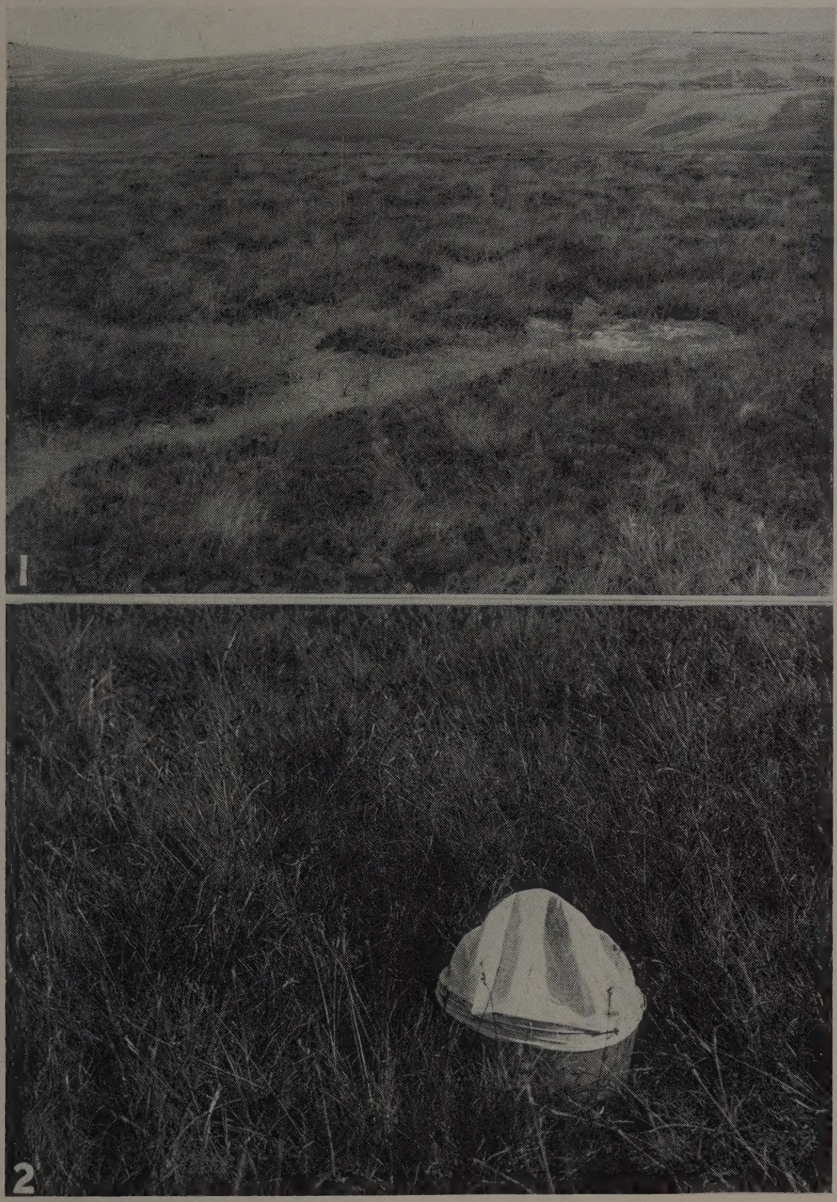

PLATE I

Fig. 1.—Top of Bog Hill, looking east. An area of actively growing bog; the vegetation consists of *Sphagnum, Eriophorum* and *Calluna*. *Tipula subnodicornis* occurs in this area.

Fig. 2.—Peat moor dominated by *Juncus squarrosus*. *Tipula subnodicornis* occurs abundantly in this area.

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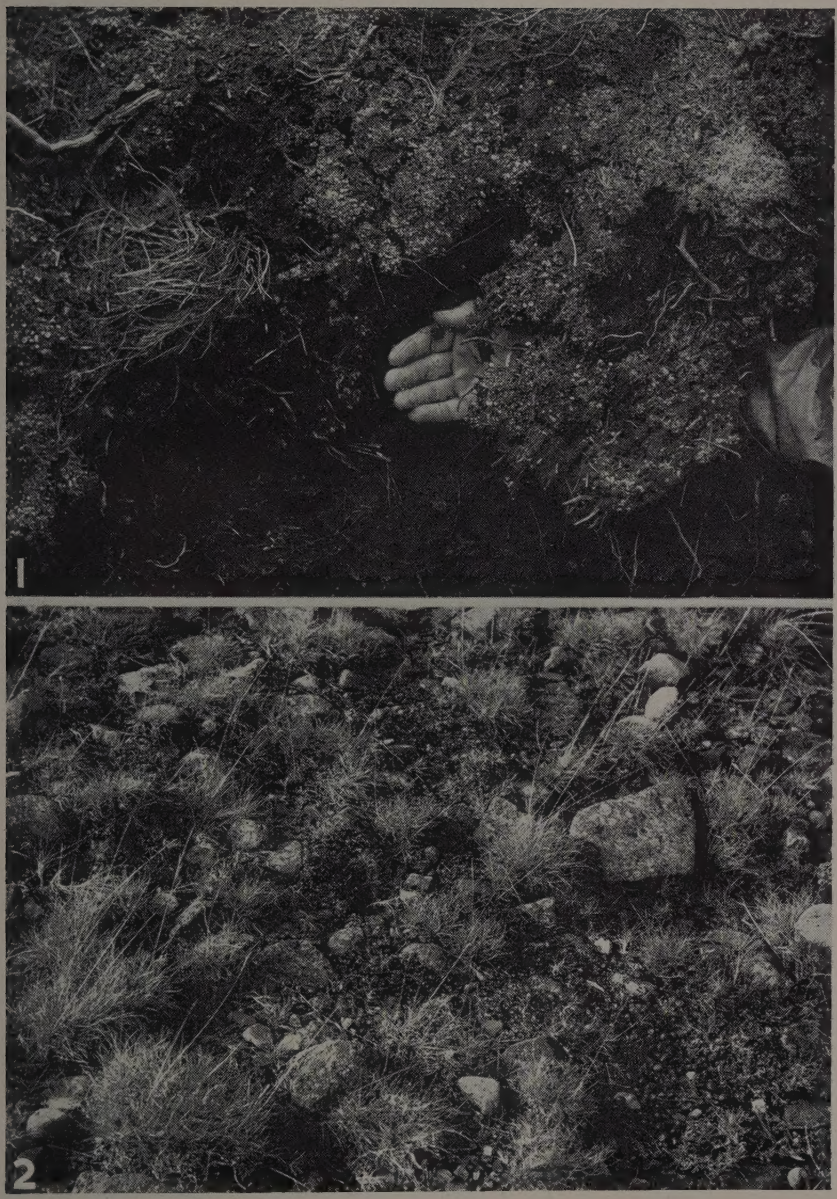

PLATE II

Fig. 1.—The vertical face and overhang on a peat bog. These sheltered areas were frequented by *Tipula alpium*.

Fig. 2.—Shingle bed which was rarely covered by the flood water of Trout Beck. This area is a larval habitat of *Tipula excisa*.

J. C. Coulson.